INDOOR AIR QUALITY INCIDENT RESPONSE

Coyle & Cassidy High School
2 Hamilton Street
Taunton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
December 2006

Introduction/Background

At the request of the Taunton Health Department (THD), the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) provided assistance and consultation concerning an incident at Coyle & Cassidy High School (CCHS), a catholic secondary school located at 2 Hamilton Street, Taunton, MA. On November 6, 2006, a visit was made to the CCHS by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program to observe environmental conditions that may have contributed to symptoms reported by students in the gymnasium.

As reported by Kevin Duquette, Environmental Compliance Officer for the THD, a church service was being held in the school gymnasium at approximately 9:30 AM on November 6, 2006, when a student fainted upon entering the gymnasium. The service was reported to have lasted several hours during which students visited the school nurse complaining of various symptoms (e.g., excess heat, headaches, dizziness, nausea). Due to these concerns the Taunton Fire Department (TFD), Emergency Medical Services (EMS) and the THD were contacted. Subsequently, seven students were sent to Morton Hospital for medical evaluation, all students reported being "hot". No complaints of strange odors or other potential pollutants/contaminants (e.g., idling vehicles, chemical usage, fuel odors) were reported.

According to Maintenance Supervisor, Archie Royster, the mechanical ventilation system was operating to circulate air but the *heating elements were* deactivated during the service. Windows on each side of the gym and exterior doors at the front and rear of the gym were all reported to have been opened to provide cross-ventilation during the service.

However, the weather was unseasonably warm on the day of the incident with an outdoor temperature of 63 ^{o} F.

Methods/Results

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a HNu Snap-on, Photo Ionization Detector (PID). The tests were taken at approximately 4:30 PM while the gymnasium was unoccupied. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that the carbon dioxide level in the gymnasium at the time of testing was close to ambient/background levels and well below the MDPH guideline of 800 parts per million (ppm) for publicly occupied buildings. These levels would be expected in an unoccupied area with exterior doors and windows open, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with increased occupancy. In subsequent correspondence with Mr. Duquette, he reported that the gym has an occupancy permit for 400 during bingo games; there were an estimated 750 individuals present during the service indicating that the gym may have exceeded its recommended occupancy. When this happens a buildup of common indoor air pollutants can occur, which can lead to discomfort or health complaints.

Mechanical ventilation is provided by two air handling units (AHUs) that draw fresh air via air intakes and deliver air to the gym through wall-mounted vents. Exhaust ventilation is provided by exhaust vents located under the stage that duct air to rooftop exhaust motors. Although the heating system was not activated during the service, Mr. Royster reported that the air handling systems were operating during the service to provide air exchange.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration

(OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

The temperature measured in the gymnasium (75 ^{o} F) was within the MDPH recommended comfort range during the assessment. Please note that this measurement was taken several hours after the incident took place. Higher occupancy would result in elevated temperatures and relative humidity; due to body heat and water vapor produced during respiration (the relationship between temperature and relative humidity is called the heat index). The MDPH recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the gymnasium during the assessment was 47 percent, which was within the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The

sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Other Concerns

Even though symptoms reported (i.e., headaches, dizziness, nausea) are consistent with insufficient fresh air in a building, CEH staff performed carbon monoxide testing to determine whether combustion products were present in the gymnasium as they can result in similar effects. Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical

Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Carbon monoxide concentrations in the gymnasium at the time of the assessment were non-detect or ND (Tables 1). Carbon monoxide levels measured outside the gymnasium were also ND at the time of the assessment (Tables 1).

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the gymnasium, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC concentrations were also ND (Table 1).

Conclusions/Recommendations

Please note air measurements are only reflective of the indoor air concentrations present at the time of sampling. At the time of air testing the gymnasium was unoccupied and no measurable levels of TVOCs or carbon monoxide were detected. In addition, no obvious

point sources were identified that appeared to be associated with symptoms reported by occupants at the CCHS. In subsequent correspondence with Mr. Duquette on November 30, 2006, it was reported that no further complaints or incidents were received by the THD. Therefore it is likely that symptoms experienced by individuals are attributable to a lack of adequate fresh air coupled with higher temperatures.

In view of the findings at the time of the visit, the following recommendations are made to improve indoor air quality:

1. Continue to operate the mechanical ventilation system during occupancy.
2. Continue to use cross-ventilation using openable windows and exterior doors. Consider using stand-up industrial fans to circulate air.
3. Consider reducing size of assemblies to prevent over-occupancy and reduce heat load.
4. Consider adopting a balancing schedule of every 5 years for mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
5. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

References

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2000. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

TABLE

Indoor Air Test Results: Coyle & Cassidy High School, Taunton, MA **Date: November 1, 2006**

Location	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
Background	429	58	63	ND	ND					Atmospheric conditions: unseasonably warm, fog, light rain, wind: SW 5-10 MPH
Gymnasium	468	47	75	ND	ND	3	Y	Y	Y	

*** ppm = parts per million parts of air**
TVOCs = total volatile organic compounds

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Table 1